PCAS 15 (2012/2013)

Supervised Project Report
(ANTA604)

A summary of the data collected by waste and litter monitoring programs carried out by PCAS students around Scott Base, Antarctica

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Abstract

Under the Environmental Protocol, Antarctica New Zealand has to comply with certain monitoring practises to assess the effect of Scott Base on the surrounding environment. A Graduate Certificate of Antarctic Studies (GCAS) student developed a monitoring procedure for litter around the base in 2001. Since then, GCAS and now Post-graduate Certificate of Antarctic Studies (PCAS) students have engaged in a systematic analysis of litter found at certain sites round the base and the overall waste production of the Base. Observation of these sites and analysis of previous data has the potential to show trends which would otherwise not be evident. Data has been collected for a number of years however these have not been previously been summarised. The objective of this report was to pool the data from the various years observation. No trends were evident in the data though this may be the result of limitations in the collection of the data. A number of recommendations are made and the protocols have been updated to make results obtained in future years more useful. The main recommendation is that a database of PCAS environmental reports and data be maintained into the future.

Contents

1 - Introduction

Antarctica is one of the last pristine environments to exist on the planet (Antarctica New Zealand 2010). Through the Protocol on Environmental to the Antarctic Treaty 1991 (EP), the parties to the Antarctic Treaty System recognised this, and "convinced of the need to enhance the protection of the Antarctic environment and dependent and associated ecosystems," (Preamble EP) set out to develop a "comprehensive regime" to protect that environment (Committee for Environmental Protection 1998).

Environmental monitoring and reporting is a fundamental part in the environmental management framework required by the EP. Article 3.2e requires state parties to "engage in regular and effective monitoring" to facilitate early detection of the possible unforeseen effects of activities carried on…within the Antarctic Treaty area…" Furthermore, under Annex III of the EP, guidelines on waste management include a requirement that to the maximum extent practicable, all waste created by a country should be returned to the country from which the activities generating the waste were organised (Article 1.4) (Committee for Environmental Protection 1998).

New Zealand plays a major role in the Antarctic Treaty System, as a claimant state from longitudes 160˚east to 150˚ west and as an original signatory party to the Antarctic Treaty in 1959. The state has retained a permanent presence on Ross Island, located at 77˚51′ S, 166˚45′ E, since 1957.

> "Antarctica New Zealand is continuing to develop a monitoring programme aimed at identifying and tracking the impacts of its own activities, and is involved with both regional level and Antarctic wide state of the environment reporting initiatives" (Antarctica New Zealand 2013)

Every year from 2004, students of the University of Canterbury's Graduate Certificate in Antarctic Studies (GCAS), more recently Post-graduate Certificate in Antarctic Studies (PCAS), have carried out environmental monitoring at Scott Base. There are four areas where monitoring has been conducted annually;

- Fixed Point Photo Monitoring
- Ground Disturbance
- Litter Survey

– Waste Survey

Prior to this report there has been no central data base or summary of the entire data set.

The aims of this project are to compile and arrange the documents available from Antarctica New Zealand and Gateway Antarctica, compile the data, assess this data for trends and put forward recommendations for future years.

1.1 - Report Database

Initially the existing files and data were sorted by years and named appropriately. Where available the protocol to which the students were working has been included in the folders. At the start of the project it was thought that the past reports would be sorted somewhat, however the available files from Antarctica New Zealand and Gateway Antarctica were unordered and in many cases unnamed. Thus the organisation and renaming of files took significantly longer than expected. The data within the files was also in a more random manner than expected, thus extraction of the data took a significant amount of time. The following students works were sorted and are now in a database for future reference (Table 1). A number of documents were available only in hard copy, and thus only scanned images have been added to the database. These files are marked in red.

Table 1. Names of students whose reports are included in the report database (See CD: database).

Year	Litter Survey	Waste Survey
2003/04	– Katrina Gousmett	
2004/05	– Catherine Tisch – Jörn Scherzer – Katja Riedel	
2005/06	– Rachael Mead	Group of Thomas Hayes, Mark Smith, Kerryn Yeats
2006/07	– Alison Mckellar – Anne Hunter – Jane Ellis – Renee Baldwin	– Gareth Jack – Matthias Danninger – Nikolai Kruetzmann – Sam Taylor
2007/08	– Andrew Atkin – Andrew Phillips	– Ana Pallsen – Nicholas Carson

	– David Balham – Fiona Wills – Scott Davidson – Victoria Winton	– Turi McFarlane
2008/09	– Group of Sarah Bouckoms, Sergey Tarasenko, Michael Tubby	– Andrew Given – Elizabeth Holland – Martina Armstrong – Phil Emnet – Sinéad Martin
2009/10	– Daniel Wainwright – Eleanor Toland – Matthias Wagner	– James Mason – Nigel Scott
2010/11	– Dan Wilson – Tessa Williams – Unnamed report	– Aurora Christensen – Jessie Herbert – Nianqi Tang – Robert Brears
2011/12	– Ruth Watson – Christel Doomas – Chanel Furborough – Sue Ferrar	– Hanne Nielsen – Penny Mauriohooho – Peter Wilson – Robyn Columbus
2012/13	– Kathy Hogarth – Nicole Calder-Steele – Peter Talbot	– Josie Hawkey – Kathleen Smiley – Nicky McArthur – Polly Miller

2.1 - Litter overview

Jenny Easton developed a monitoring procedure for litter around Scott Base in 2001 and following from this a pilot study was carried out in 2004/05. Subsequently groups from Gateway have assessed the quantity and type of litter found around the base. The evaluation consists of assessing introduced materials on the surface of ice-free land within the base perimeter.

The litter survey attempts to identify human impacts on the land through the identification of these materials. Possible negative impacts of litter include damage to local ecosystems and damage to aesthetic appreciation of the Antarctic environment. The data returned from the evaluation may be used to change base operating procedures.

The data in the litter surveys is currently collected by students following the following protocol (Figure 2**)**. It is worth noting that the protocol has changed slightly over the years.

PCAS%%Scott%Base%Environmental%Monitoring:%Litter%Survey%

This project was initiated by a GCAS student's individual project in 2001/2002. The results of the surveys are a useful indicator of local environmental impact, and help Antarctica New Zealand manage the 'footprint' of Scott Base. The method for this project is simple, but it gives a very useful set of data. The aim of this project is to quantify the extent and nature of contamination by anthropogenic materials around Scott Base and compare it to previous seasons.

Sites%

Litter surveys should be conducted at four different sites. The sites are near the:

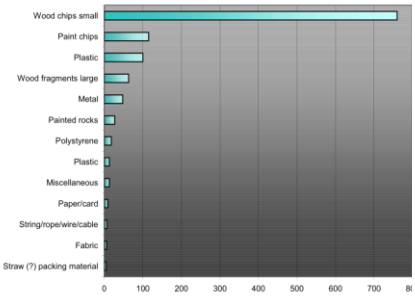
- Kitchen – southwest corner
- Hangar - southwest corner
- Hillary Field Centre - north east corner
- TAE Hut - approx. 20m to the south
- In some years, students have added other sites. If time allows, feel free to replicate the monitoring at these additional sites.

Materials%

- 2 quadrats (1x1m) (GA to provide)
- Measuring tape (GA to provide)
- Camera (your own)
- Hand lens (GA to provide)
- Scott Base map (http://ims.geog.canterbury.ac.nz/anta/scott_base_envi_gis/)
- Litter tally form (Table 1 below)
- Reports and data from previous surveys (GA to provide)

Method%

- At each of the four sites (or more if time allows), randomly throw out the two quadrats. If they do not land on snow-free ground, throw again.
- Take a photograph and draw a sketch of each quadrant.
- Identify and tally foreign objects (i.e. human origin) within each quadrat.
- Sketch distribution of litter in each quadrant
- Mark locations of sites on a map of Scott Base
- Analyse data and compare to previous years



Litter survey method (left) and sample data (right) both from 2004-05 GCAS group

Sample litter tally form

Group:			
Date: Start + finish time:			
Site:			
Quadrat:			
Item description:	Tally:	Approx. size distribution:	Total:
Fabric%			
Metal			
Paint fragments			
Painted rocks			
Paper/card			
Plastic			
Polystyrene			
String/rope			
Wire/cable			
Wood (fragments)			
Wood (larger pieces)			
Other(s)			
Comments, Notes, Observations:			

Figure 2. Protocol for which Litter survey was carried out for the 2012/2013 PCAS group.

2.2 - Litter Results and Discussion

The data for the years for which the raw data was available, have been compiled into a spread sheet (**Litter Master.xlsx**). The raw data is included within this spread sheet along with an overview which brings together the data from the different years. This data was obtained by reading through all past reports. Since the datasets often describe items which were included in the 'other' category it was possible to add additional categories to the overall data set. All data once collated were converted into a count per metre squared as this best represents the method of data collection and allows standardisation across all GCAS/PCAS groups.

Years for which raw data were not available were not included in the data sets as the conversion of graphs into raw data has the potential to introduce bias depending on the reading of the graphs.

Results obtained by the various year groups were standardised to 'per metre squared' values which were then used for analysis and interpretation. The four main sites, namel: outside the Hillary Field Center (HFC) Trans-Antarctic Expedition (TAE) hut, Hanger; and Kitchen were surveyed in every year, while the area around the fuel tanks was only surveyed intermittently.

Looking at all the Scott Base samples, there were large amounts of wood and string/rope found over a number of years (Figure 2) .

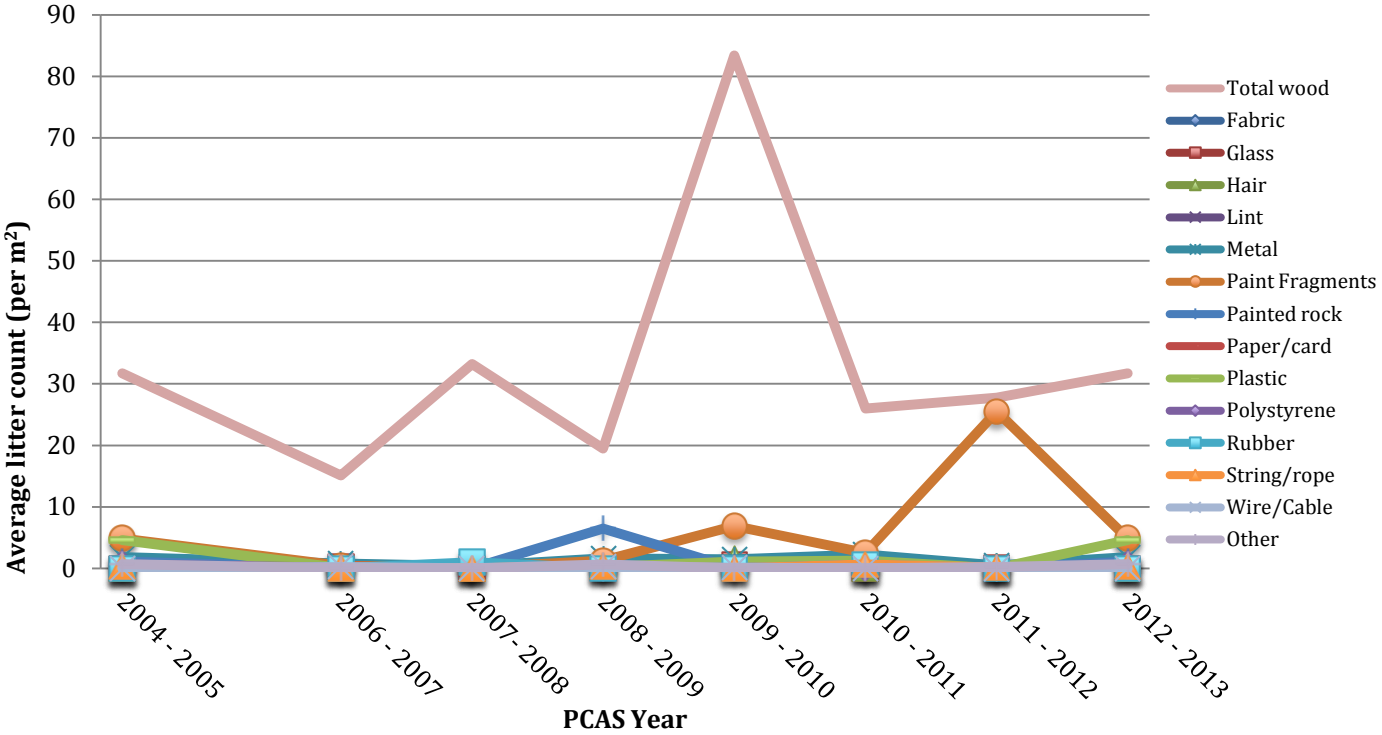


Figure 2. Comparison of the amount of litter observed per square metre across all sites over the years the survey has been carried out. Note that in certain years not every item of litter was counted which may underestimate totals (see text).

This data showed that generally there are no trends over time as to the amount of any particular type of litter found around the base. The amount of wood found around the base fluctuated significantly over the years, however this fluctuation may in part be to not all fragments being counted each year, such as where only numbers such as '20+' were recorded (See 2004/05).

Data from individual locations showed a similar lack of trends over time, however in certain sites there were significant year on year differences, this was particularly evident for the Hanger (Figure 3).

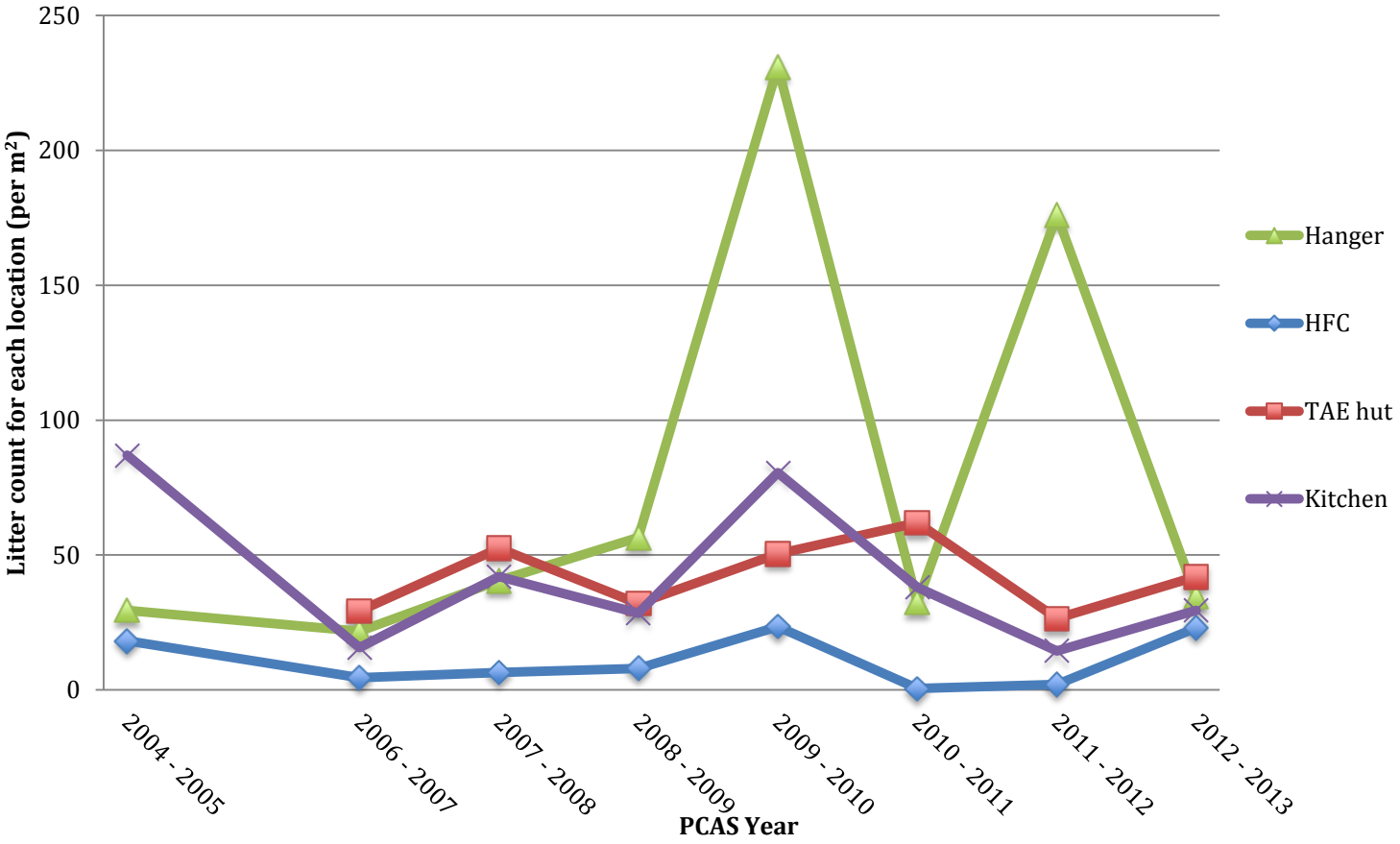


Figure 3. Comparison of the amount of litter observed per square metre across all sites over the years the survey has been carried out. Note, certain years have underestimation of litter due to not counting every single piece of litter.

From this figure there in no apparent change over time for any of the locations.

Figure 2 suggests that the majority of litter is wood chips. It was therefore decided to re drawing this graph excluding wood chips since they could be masking other trends (Figure 4).

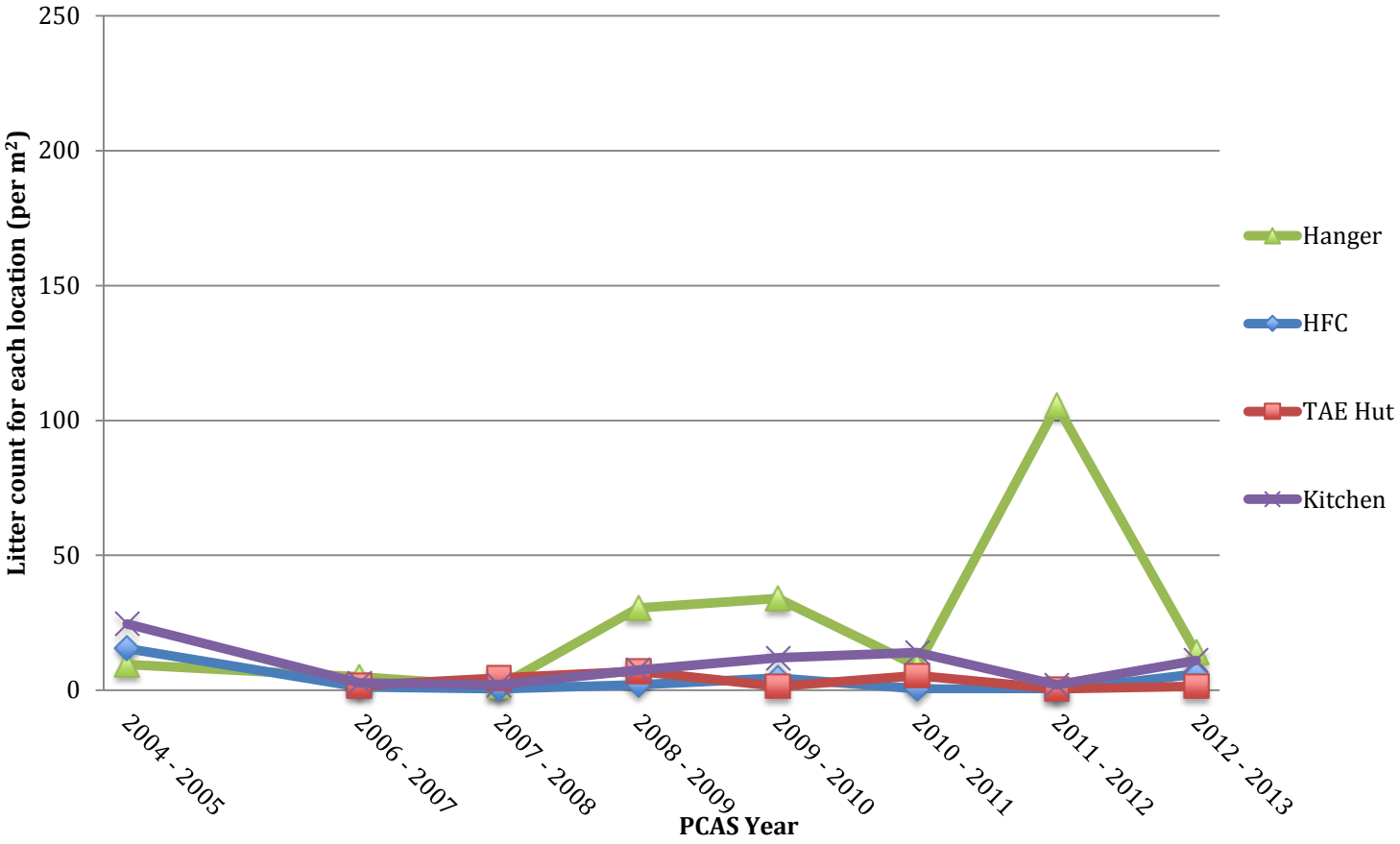


Figure 4. Comparison of the amount of litter observed per square metre across all sites over the years the survey has been carried out. Note, certain years have underestimation of litter due to the people not counting every single piece of litter.

The high amount of litter, found around the hanger, which is obvious in the 2011/2012, is the result of a large amount of paint chips. Overall there is no change is evident across all locations over the years

Although there is no obvious decrease in litter from the data shown here, it has been stated in a number of reports that the there is evidence of a decrease. This conclusion is most likely the result of only comparing datasets from a few years rather than looking at the overall picture.

2.3 - Litter limitations and Recommendations

A major limitation of the data set is the apparent lack of motivation of the individuals carrying out the survey. Rather than counting every piece of litter in a location it was relatively common for people to stop counting at some number such as 20 or 50. For example in 2004/05 the counts stop at seemingly random numbers for example 20+, 40+ and 80+. The lack of knowledge of exactly how much litter was present in each location severely limits the conclusions that can be drawn from the data. In the future the use of some form of estimate would be more useful for data interpretation than 'greater than' when the actual number is difficult to count

Another factor possibly influencing the quality of data is the amount of time and circumstances around the data collection: The 2011/12 group collected their data as part of a fourteen hour decamp day. The group responsible commented in their reports that the data is unlikely to be of high enough quality and as such I question whether it should actually be used for comparison. Although it is impossible to guarantee enough time within the PCAS schedule I feel it is of utmost importance that at least a morning is set aside for the environmental projects.

In the past, categories have been merged, which makes the identification of trends for particular litter types more difficult. Examples are combining string/ rope and wire/cable, wood and wood fragments. The loss of data from combining groups limits the use of the data. This can be avoided in future by ensuring that the categories are kept separate, and if litter is placed into the "other" category there should be a brief description of the item. Closely related to the merging of categories is the lack of standardisation of 'wood fragments' and large pieces. The definition of these two types of litter seem to have changed between most years so that all wood pieces need to be counted as one category when analysing the data. In the future, a precise definition of a fragment (e.g. under 2cm long) would help distinguish the between a "piece" and a "fragment".

The sample is very limited with only two areas at each specified location being sampled. Although there are time constraints it would significantly improve the quality of the data set to increase the sample size, by sampling a larger number of

quadrats. The main benefit of this would be the ability to identify outliers and reduce the bias in the data.

The time of year that the survey is undertaken is significant in that for the majority of the season the area sampled is covered in snow therefore any efforts from Scott Base personnel to eliminate litter on the ground is limited to the short summer period where snow has melted, namely December and January. Random sampling can be limited depending on the time of the season and this may bias the results somewhat. A further factor that may impact the litter found and is related to the melting of snow is that as snow melts there is significant amount of grading and soil movement on the roads around the base which may result in litter being relocated or buried. Past surveyors have commented on this influence in the area around the HFC survey site.

Some of the studies were carried out following a general clean up around the base, this may decrease the amount of large pieces of rubbish while leaving behind smaller pieces depending on the motivation of those involved. Dividing the base into clean-up zones to ensure complete clearance of specific areas when implementing a clean-up could possibly be a more efficient and targeted way of eliminating litter around the buildings. Discussions with base staff to identify zones would need to occur and implementation of this as a clean-up strategy would require minimal effort. A few past students have observed that groups are currently not expected to remove litter found. This would be problematic as it has the potential to skew future results however the environmental merits of such activity need to be looked into.

Regarding the final reports, it has been questioned in the past if there is merit in the writing of multiple reports for one dataset. Reading through all the reports, the same conclusions appear to be reached by all group members. This is possibly due to groups discussing their conclusions prior to the writing of the reports. The value of multiple reports depends on the perspective from which the projects are viewed. From a Gateway Antarctic academic perspective it is beneficial as it involves each individual writing a report, but to most benefit Antarctica New Zealand I feel that a more thorough analysis of the data could be carried out if the report is written as a group.

The details included within the reports varied significantly between reports. The majority of data was included within appendices, however entering data into a centralised database would ensure data is not lost.

The final observation is that there have been a number of comments and recommendations as to how the methods could be improved included within past reports but these have not been acted on. I strongly recommend that the reports are reviewed every year, and the recommendations made are recorded and changes to the protocol are made if required.

As a result of the recommendations above, I have made a number of suggested changes to the protocol for future PCAS groups, mostly based around the categories (See Appendix 1).

3.1 - Waste Audit Overview

All waste that is produced within Scott Base, and in fact within Antarctica has to be managed in a way that minimises cost and damage to the environment. Antarctica New Zealand complies with the regulations set by The Protocol on Environmental Protection to the Antarctic Treaty (The Protocol). Annex III of The Protocol deals with waste disposal and waste management and states that;

> "The amount of wastes produced or disposed of in the Antarctic Treaty area shall be reduced as far as practicable so as to minimise impact on the Antarctic environment and to minimise interference with the natural values of Antarctica, with scientific research, and with other uses of Antarctica which are consistent with the Antarctic Treaty" (Committee for Environmental Protection, 1998, p. 1)

Minimization of waste has financial implications for Antarctica New Zealand as there is a cost to bring all waste back from Antarctica and incorrect waste streaming increases the cost of destruction once in Christchurch. Sustainability is also a core value of Antarctica New Zealand (Antarctica New Zealand, 2010, p. 2). The waste audit has been carried out by PCAS on behalf of Antarctica New Zealand since 2004/05 and constitutes part of the annual review required by The Protocol.

The audit aims to look at; the total volume of waste produced both on a global base scale and per person; the proportion of waste incorrectly streamed; and how the waste handling and management could be improved to minimise landfill.

The data in the litter surveys is currently collected by students following the following protocol (Figure 5).

PCAS 5 Scott Base Environmental Monitoring: Waste Audit Project

Your group will be auditing Scott Base waste to measure the effectiveness of the waste management systems there. The aim of this project is to audit three days of waste, compare the data to previous audits and provide recommendations to Antarctica New Zealand from your results.

Key questions are (in order of priority):

- What proportion of waste is going to landfill?
- How much waste has been produced per person per day?
- How much waste is incorrectly streamed?
- How could more waste be diverted from landfill?
- How do your results compare to previous audits?
- How could AntNZ improve its waste handling?

Sites

The Scott Base engineers will have put aside waste from three full days of activities. It will be in the hangar. You may also want to look around the other parts of the waste streams from the bins inside Scott Base to the containers outside ready to ship it home.

Materials

- Gloves and overalls (see engineering staff)
- Scales (in the hangar)
- Camera, note paper (bring your own)
- Reports and data from the previous audits (GA to provide)
- Waste management handbook (on AntNZ website http://www.antarcticanz.govt.nz/images/downloads/publications/waste_manual_2010.pdf)
- An example of a spreadsheet for analysis (AntNZ to provide)
- Sense of humour

Method

- Set up a table for recording your data. Use the previous waste audit data to help you with this. Weigh and record the number of bags that have been allocated to each waste stream. Analyse the data so that you can report on how much waste has gone to landfill and how much is recycled. Use the Christchurch audit analysis technique to produce waste per person per day figures (one for landfill and one for recycling) for Scott Base.
- Go through the bags and weigh the amount of waste that is incorrectly streamed. Make recommendations on where improvements could be made to divert more waste from landfill.
- Talk with the staff about how the waste management system is working and where the waste goes from the hangar.
- Analyse your data and the data collected in the previous audits to compare.
- Make recommendations on any improvements to the waste system and the waste audit process.

Figure 5. Protocol for which Litter survey was carried out for the 2012/2013 PCAS group.

It is worth noting that the protocol has changed slightly over the years, in particular the number of days for which rubbish was collected.

3.2 - Waste Results and Discussion

The data for the years which the raw data are available have been compiled into a spread sheet (**Waste Master.xlsx).** The data was obtained by reading through all past reports and extracting the results. The data sets from each year were not particularly comparable due to large changes between the protocols and data collected in any given year (Figure 6).

	2005/06	2006/07	2007/08		2008/09			2009/10	2010/11	2011/12	2012/13
	Jan-06	Jan-07	Jan-08		Dec-08			Dec-09	Dec-10	Dec-11	
Recyclables - Green Bags	Waste (Kg)				Weight	% Correct	Cardboard	19	15.6	23.76	7.26
Cardboard/Paper	156.05	122.01	6.55	Paper Stream	60	92.63%	Paper	10.6	14	6.15	75.3
Glass	27.47	103.66	-	Cardboard Stream	5.909	-	Glass	38.82	-	32.3	-
Aluminium	24.86	20.2	1.12	Aluminium Stream	19.38	97.52%	Aluminium	9.41	16.5		67.59
Tins/Steel	9.83	19.09	6.55	Tin/Steel Stream	101.36	91.48%	Tin/Steel	5.38	6.9	5.02	45.36
Plastics	3.07	3.34	2.1	Plastic Stream	34.55	94.73%	Plastics	9.08	3.4	4.47	17.69
Total Recyclable Collected	223.66	270.68	18.1				Recyclable totals	90.88	56.4	71.7	213.2
Misplaced	2.38	-	-								
Total Recyclable Waste	221.28	-	-								
Percent Correct	98.94%	50.00%	-								
Non Recyclables											
General Waste - Black Bags				General Waste Stream	36.36	86.82%	General Waste	20.1	20.3	25.04	45.36
Total Collected	94.33	118.2	6.04				Paper Towels	19.88	-	-	-
Misplaced	22.05	56.50	0.97								
Total General Waste	72.28	61.70	5.07								
Percent Correct	76.62%	47.80%	84.00%								
Food Contaminated - Blue Bags											
Total collected	82.5	116.56	67.85				Food Contaminated	20.61	57	16.7	58.39
Misplaced	22.15	-	-				Food	24.13	-	-	-
Total Food contaminated	60.35	-	-								
Percent Correct	73.15%	-	41.00%								
Food Scraps	-	796	39.78								
Overall - Food Collected	400.49	505.44	51.06	Total Waste	91.03		Total Waste	157.35	133.7	113.44	316.95
Overall Misplaced	46.58	17.18	0.56								
Date	13-20-Jan	January	1- 3-Jan	Dates	20-24-Dec		Dates	27- 29 Dec	24-26Dec	24-26 Dec	15-17 Dec
Days	7	7	2	Days	4		Days	-	3	3	3
Average People	-	-	30	Average People	-		Average People	-	46	47	73.33
							Per person day				
Waste per person day	-	-	1.52				Total waste	0.92	0.97	0.80	1.44
Recyclable waste per person	-	-	0.31				Recyclable	0.54	0.41	0.51	0.97
General Waste	-	-	1.21				General	0.38	0.15	0.18	0.21

Figure 6. Total accumulated data for waste audits carried out at Scott Base. All measurements are in kilograms. A ”-“ represents missing data.

From looking at the datasets it appears that the amount of miss-streamed litter has decreased over the years. This means that the amount of litter incorrectly placed in a certain waste stream has decreased Since many groups did not look at or identify miss-streamed waste this conclusion has low reliability; the years which showed low miss-streamed volumes, such as 10/11 may be an anomaly rather than the trend.

The only graph that can be produced from the data suggests an increase in the amount of pollution created, however due to a number of flaws in the data (see page 18) this may not be a valid conclusion (Figure 7).

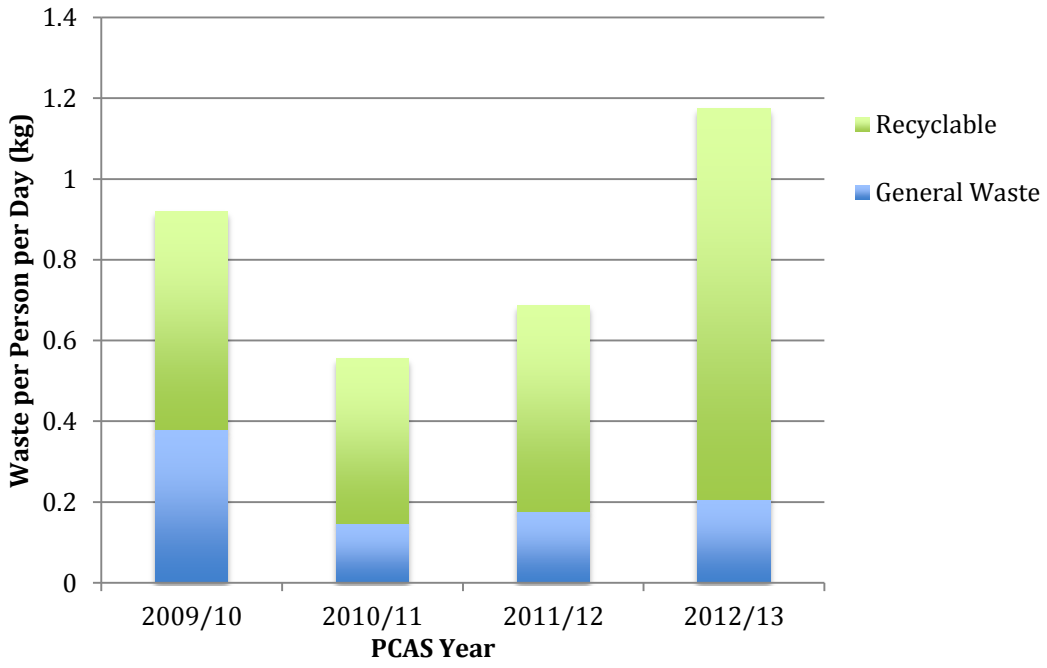


Figure 7. The amount of waste produced per person per day for similar periods of December for the past four years.

The data obtained year on year is not directly comparable due to a number of reasons. Below I outline the flaws with each year's data (Table 2)

Table 2. The problems found within datasets from each year.

05/06	– Food scraps not measured – No population data
06/07	– No population data – No dates of waste collection – Raw Misplaced data not provided
07/08	– Cardboard, paper and glass not measured – Unknown length of Aluminium collection which included New Years – No population data
08/09	– Cardboard, Food Contaminated and Food waste not measured – No population data
09/10	– Although waste per person per day is recorded base population is not given – Misplaced data not provided
10/11	– Waste collected over Christmas holiday – Glass not measured
11/12	– Waste collected over Christmas holiday – Data extrapolated from only measuring 10% of waste
12/13	– Food waste from kitchen not included – Misstreamed not included

The lack of cohesion between the data sets makes the drawing of any conclusions from the data an unwise one. The lack of population data, sampling dates, and different waste streams being measured means that it is nearly impossible to compare the different year's waste results.

3.3 - Waste Recommendations

At first glance the data collected appears to be comprehensive, complete and useable for a number of statistical analyses however this is not in fact the case. The data has a number of major limitations. The first is the lack of population and time period data which means the data from many years cannot be standardised. The further lack of data stemming from the inclusion of Christmas and New Year festive periods has the potential to significantly bias the data. These are periods where the base produces a higher amount of waste than normal. Years where paper towels were included in the waste audit, unsurprisingly showed higher overall amounts.

The lack of data on the population in the base during the audit is something that can easily be rectified in the future. As such a new table for the input of data has been created (See Appendix II). Other data, which was not often included, includes notes on the significant events around base. Events such as groups decamping and Thursday America bar night have the potential to influence the data. Other more day-to-day procedures such as kitchen/bar breakout, the preparation of food boxes, and Emu parades all have the potential to influence the results and should be included in notes in future reports.

Including raw data within the appendices would help with the breakdown of misplaced waste Although the data in the current database suggests an improving trend, the large gaps mean that this is a difficult conclusion to draw. A number of gaps in the existing datasets are not due to the data not being measured rather that the writers of the reports did not feel that the data worthy enough to include, and thus merely hint at the results found. The new protocol suggested in Appendix II addresses the recording issue and the inclusion of this table into all future reports would be highly beneficial. In addition the use of a centralised, standardised database would help with accuracy and retention of data.

Time of the year is something which changes throughout the years of data collection. In recent years the audit has been carried out in late December whereas in the past the audits were in mid-January. Due to the change in time I question whether the data sets even if complete would be truly comparable. Having the survey carried out by Scott Base staff at regular intervals could produce more relevant data.

As mentioned for the litter survey regarding to the final reports, it has been questioned in the past whether there is much merit in the writing of multiple reports for the same dataset. Waste reports again showed similar conclusions being drawn by all members of the data collection group. Again, the benefit of multiple reports for Gateway Antarctica is obvious as an academic exercise. However Antarctica New Zealand's interest may be better served by a single collaborative report. Currently many recommendations with much merit do not appear to be acted on and a single report with unified recommendations would carry more weight for Antarctic New Zealand. I strongly advise that the reports are reviewed every year, and the recommendations made are recorded and changes to the protocol are made if so required.

4 - Overall Conclusions

Analysing the two data sets was a surprisingly large task which perhaps should have been carried out by two people rather than one. Overall the litter survey yields more useable data than the waste audit. Both environmental projects had a number of limitations which decreased the value of the data. The waste audit showed significant flaws in the dataset which means that no conclusions can be drawn. The quality of the data sets mean that further more in depth analysis will not necessarily be beneficial. For the two environmental projects to be of more use in the future it is essential that datasets are the consistent from year to year. It is strongly recommended that the updated protocols as shown in the appendices are used.

Key recommendations are as follows;

- Updated protocols.
- Maintenance of database.
- Raw data being placed in the appendices of the reports.
- Students need to be aware of the value of the data they are collecting; this value needs to be supported administratively with adequate time allocated to data collection.
- Follow up on the recommendations made within reports.
- Group reports may more useful to Antarctica New Zealand.

5 - References

Antarctica New Zealand (2010). *Waste Management Handbook.* Christchurch: Antarctica New Zealand.

Antarctica New Zealand (2013). *Environmental monitoring and reporting*. Retrieved February 1, 2013, from Antarctica New Zealand: http://www.antarcticanz.govt.nz/environmental-stewardship/environmental-monitoring-and-reporting

Committee for Environmental Protection (1998).\ *Protocol on Environmental Protection to the Antarctic Treaty.* Buenos Aires: Secretariat of the Antarctic Treaty.

6 - Appendix 1
PCAS – Scott Base Environmental Monitoring: Litter Survey

This project was initiated by a GCAS student's individual project in 2001/2002. The results of the surveys are a useful indicator of local environmental impact, and help Antarctica New Zealand manage the 'footprint' of Scott Base. The method for this project is simple, but it gives a very useful set of data. The aim of this project is to quantify the extent and nature of contamination by anthropogenic materials around Scott Base and compare it to previous seasons.

Sites

Litter surveys should be conducted at four different sites. The sites are near the:

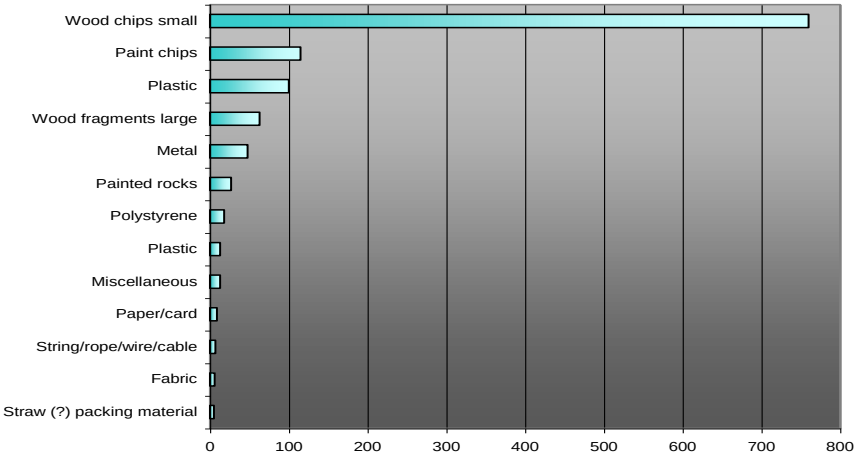
- Kitchen – southwest corner
- Hangar - southwest corner
- Hillary Field Centre - north east corner
- TAE Hut - approx. 20m to the south
- In some years, students have added other sites. If time allows, feel free to replicate the monitoring at these additional sites.

Materials

- 2 quadrats (1x1m) (GA to provide)
- Measuring tape (GA to provide)
- Camera (your own)
- Hand lens (GA to provide)
- Scott Base map (http://ims.geog.canterbury.ac.nz/anta/scott_base_envi_gis/)
- Litter tally form (Table 1 below)
- Reports and data from previous surveys (GA to provide)

Method

- At each of the four sites (or more if time allows), randomly throw out the two quadrats. If they do not land on snow-free ground, throw again.
- Take a photograph and draw a sketch of each quadrant.
- Identify and tally foreign objects (i.e. human origin) within each quadrat. It is important that every item is counted. If the number of items is too large count a representative sample and extrapolate.
- Sketch distribution of litter in each quadrant
- Mark locations of sites on a map of Scott Base
- Analyse data and compare to previous years
- Add your data to the spreadsheet that GA will provide and return to course coordinator prior to the end of the course



Litter survey method (left) and sample data (right) both from 2004-05 GCAS group

Litter tally form, Note Wood fragments are smaller than 2cm long.

Group:	
Date: Start + finish time:	
Site:	
Quadrat:	

Item description:	Tally:	Approx. size distribution:	Total:
Fabric			
Glass			
Hair			
Lint			
Metal			
Paint Fragments			
Painted rock			
Paper/Card			
Plastic			
Polystyrene			
Rubber			
String/Rope			
Wire/Cable			
Wood (Fragments)			
Wood (Larger pieces)			
Other			

Comments, Notes, Observations:

Appendix 2
PCAS – Scott Base Environmental Monitoring: Waste Audit Project

Your group will be auditing Scott Base waste to measure the effectiveness of the waste management systems there. The aim of this project is to audit three days of waste, compare the data to previous audits and provide recommendations to Antarctica New Zealand from your results.

Key questions are (in order of priority):

- What proportion of waste is going to landfill?
- How much waste has been produced per person per day?
- How much waste is incorrectly streamed?
- How could more waste be diverted from landfill?
- How do your results compare to previous audits?
- How could AntNZ improve its waste handling?

Sites

The Scott Base engineers will have put aside waste from three full days of activities. It will be in the hangar. You may also want to look around the other parts of the waste streams - from the bins inside Scott Base to the containers outside ready to ship it home.

Materials

- Gloves and overalls (see engineering staff)
- Scales (in the hangar)
- Camera, note paper (bring your own)
- Waste audit form (See Table 1)
- Reports and data from the previous audits (GA to provide)
- Waste management handbook (on AntNZ website http://www.antarcticanz.govt.nz/images/downloads/publications/waste_manual_2010.pdf)
- An example of a spreadsheet for analysis (AntNZ to provide)
- Sense of humour

Method

- Use the attached table to record your data. Weigh and record the number of bags that have been allocated to each waste stream. Analyse the data so that you can report on how much waste has gone to landfill and how much is recycled. Use the Christchurch audit analysis technique to produce waste per person per day figures (one for landfill and one for recycling) for Scott Base.
- Go through the bags and weigh the amount of waste that is incorrectly streamed. Make recommendations on where improvements could be made to divert more waste from landfill.
- Talk with the staff about how the waste management system is working and where the waste goes from the hangar.
- Analyse your data and the data collected in the previous audits to compare.
- Add your data to the spreadsheet that GA will provide and return to course coordinator prior to the end of the course
- Make recommendations on any improvements to the waste system and the waste audit process.

Waste Audit form

Members:	
Date of Audit:	
Waste Collection Dates:	
Total days:	
Average number in Base:	

	Type:	Weight (kg):	% of Total:	Misplaced %:	Notes on misplaced:
Landfill	General Waste				
	Food Contaminated				
	Food Scraps				
Recycling	Cardboard Recycling				
	Paper				
	Glass				
	Plastic (1-6)				
	Aluminium				
	Steel/Tins				

	Weight (kg)	Percent of Total	Per Person per Day
Total Recycling			
Total Landfill			
Total Rubbish			

Comments, Notes; (e.g. Parties arriving from field, or special events)

7 – Data CD

Contents –

Data – Waste Audit and Litter Survey Reports 2004/05 to 2012/12

Spread sheet with data in

Write up of supervised project